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Field Evaluation of TDC/Intera MARINE-VUE Upgrades Final Report

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16. Abstract

This report presents the results of a field trial of a prototype of navigation marine radar display system called MARINE-VUE developed by Intera Technologies Limited under the sponsorship of the Transportation Development Centre. The field trial took place onboard the M.V. Arctic during the November, 1988, commercial voyage to and from the minesite at Nanisivik, N.W.T., in the eastern Canadian Arctic.

The MARINE-VUE upgrades tested included the additions of radar video enhancement functions such as gain control and STC (Sensitivity Time Control) curves on the system. In addition, the STAR-VUE system was upgraded to allow the operator to mark a ship's position on the SAR display based on the analysis of the MARINE-VUE display.

The field trial was successful and resulted in many recommendations on the direction of future developments in ice navigation technology.

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16. Résumé

Ce rapport présente les résultats des essais en mer d'un prototype du système de visualisation radar de navigation maritime MARINE-VUE, réalisé par Intera Technologies Limited, sous la commandite du Centre de développement des transports. Les essais ont eu lieu à bord du N.M. Arctic en novembre 1988, à l'occasion d'un périple commercial aller retour au site minier de Nanisivik (T.N.-O) dans la partie est de l'Arctique canadien.

Parmi les perfectionnements testés du MARINE-VUE, figuraient des fonctions de rehaussement de visualisation radar telles que la commande de gain et la régulation de sensibilité temporisée. Par ailleurs, le système STAR-VUE a été modifié afin de permettre à l'opérateur de repérer la position de son navire sur l'imagerie SAR à partir de l'analyse des informations fournies par le système MARINE-VUE.

Les essais en mer ont été concluants et ils ont débouché sur de nombreuses recommandations concernant l'orientation à donner aux travaux de développement futur dans le domaine de la navigation dans les glaces.

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Summary

This report presents the results of a field trial of a prototype ice navigation marine radar display system called MARINE-VUE developed by Intera Technologies Limited under the sponsorship of the Transportation Development Centre. The field trial took place onboard the M.V. Arctic during the November, 1988, commercial voyage to and from the minesite at Nanisivik, N.W.T., in the eastern Canadian Arctic.

The MARINE-VUE upgrades included a Radar Video Processor which receives the input analogue radar video and trigger information from the vessel's DECCA "X" band radar and performs a number of modifications to the signal. The marine radar video parameters manipulated by the Radar Video Processor include video offset, video gain, STC (sensitivity time control) threshold, STC time constant , FTC (fast time constant) and video blanking.

The modified output radar signal from the Radar Video Processor is sent to a FOLSOM model 8342 radar scan converter via a RS-232 connection. Ship orientation information is added to the marine radar signal at the FOLSOM scan converter from a connection to a Lemicule gyro repeater.

The functions of the Radar Video Processor and FOLSOM radar scan converter are controlled by the MARINE-VUE Control Panel (MVCP) located at the SINSS navigation console. The operator, via simple controls, inputs desired commands to the MVCP which, in turn, sends the parameter changes to the Radar Video Processor or scan converter over serial communication lines. In addition to the functions of the Radar Video Processor, the MVCP controls the options of the FOLSOM scan converter including radar display mode (variable, north-up or head-up), image rotation, range, overlay,

and range and bearing cursor.

In addition to the upgrades of the MARINE-VUE component of the system, the STAR-VUE system was also upgraded with the addition of a confirm vessel position module. The confirm vessel position module allows the operator to mark a ship's position on the STAR-VUE display based on the analysis of the MARINE-VUE display. The functions on STAR-VUE that allow the operator to determine the position of the vessel include Query MARINE-VUE, Mark Ships Position, and Centre Ship in Image options. The "Query MARINE-VUE" function generates a triangulation fix on the SAR imagery based on range and bearing information captured by STAR-VUE from the MARINE-VUE system. The "Mark Ships Position" and "Centre Ship in Image" options allow the operator to update the SAR imagery.

The November, 1988, late season commercial voyage of the M.V. Arctic to the minesite at Nanisivik, N.W.T., provided for an ideal and successful operational evaluation of the TDC/Intera MARINE-VUE upgrades. The addition of video gain control greatly improved the MARINE-VUE display and allowed the marine radar to be used in the high resolution (but weaker signal) short pulse mode. This finding illustrated the importance of shortening the arch length of the radar pulse to improve sea ice definition on the radar display. The effect of the STC function was limited to the first nautical mile of range with little to no ice detail being discernable beyond 4 n.miles of range. The investigation of methods to improve far range resolution of the MARINE-VUE display is recommended.

Unlike the MARINE-VUE upgrades, which were well received by the M.V. Arctic navigating officers, the STAR-VUE position determination upgrades were little used during the voyage. Although the functions to undertake the position determination performed adequately for part of the voyage, there was reluctance by the navigating officers to use the system onboard the M.V.

Arctic. Rather, the officers prefered to use the hardcopy output from STAR-VUE for tactical navigation. This reluctance by the officers to use the soft copy component of the system is due to a combination of factors including a limited amount of training and/or exposure to the system, an overly complex system to perform a straightforward function, and a lack of functional reliability. STAR-VUE failed during the outbound leg of the field trial voyage and, consequently, was not available for most of the field trial. Based on the level of acceptance of STAR-VUE onboard the ship during the field trial, it is recommended that manning and training programs be established for navigators required to use advanced navigation technology. In addition, it is recommended that the STAR-VUE processor be upgraded to meet state-of-the-art data processing requirements now and in the future.

Sommaire

Ce rapport présente les résultats des essais en mer d'un prototype du système de visualisation radar de navigation maritime MARINE-VUE, réalisé par Intera Technologies Limited, sous la commandite du Centre de développement des transports (CDT). Les essais ont eu lieu à bord du N.M. Arctic en novembre 1988, à l'occasion d'un périple commercial aller retour au site minier de Nanisivik (T.N.-O) dans la partie est de l'Artique canadien.

Le système MARINE-VUE perfectionné mis à l'essai comporte un processeur vidéo radar qui soumet à un certain nombre de traitements le signal vidéo radar analogique provenant du radar de bord DECCA X, accompagné d'un signal de déclenchement. Les modifications paramétriques du signal vidéo radar par le processeur comprennent: le décalage du point d'origine, le gain vidéo, le seuil d'intervention du régulateur de sensibilité temporisé, la constante de temps de ce régulateur, la constante de découpage des échos longs ainsi que la suppression sélective du signal.

Le signal radar modifié par le processeur est relayé, via une liaison RS-232, à un convertisseur de balayage radar FOLSOM, modèle 8342, lequel greffe à ce signal des informations sur la route suivie, provenant d'un répéteur de cap Lemicule.

La commande des fonctions du processeur vidéo radar et du convertisseur de balayage FOLSOM se fait à partir du panneau de commande MARINE-VUE (PCMV) sur la console de navigation SINSS. L'opérateur donne ses instructions de traitement de signal à l'aide de commandes simples du PCMV, qui est relié au processeur vidéo radar et au convertisseur de balayage par des liaisons de communication série. Outre les fonctions du processeur vidéo radar, le PCMV permet de choisir les diverses options offertes grâce au convertisseur de balayage: mode d'affichage (variable, nord en haut, avant en haut), rotation d'image, réglage de portée, superposition d'information vidéo synthétique ainsi que curseur distance et relèvement.

Outre les améliorations apportées au système MARINE-VUE, Intera a également perfectionné le système STAR-VUE en ajoutant un module de repérage de la position du navire, module qui permet à l'opérateur de repérer sa position sur l'affichage STAR-VUE à partir de l'analyse des informations du MARINE-VUE. Les fonctions de STAR-VUE utilisées par l'opérateur à cette fin comprennent les suivantes: Query MARINE-VUE (consulter MARINE-VUE), Mark Ships Position (repérer navire) et Centre Ship in Image (Centrer plot navire). La première fonction sert à déterminer la position du navire par triangulation sur l'imagerie SAR, à partir des données de distance et de relèvement extraites du système MARINE-VUE. Quant aux deux autres fonctions, elles permettent de mettre à jour l'imagerie SAR.

Le périple commercial entrepris par le N.M. Arctic en novembre 1988, soit vers la fin de la saison de navigation, en direction du site minier de Nanisivik (T.N.-O.) a été une occasion rêvée, mise à profit d'ailleurs, de procéder à l'évaluation opérationnelle du système MARINE-VUE perfectionné par Intera, sous l'égide du CDT. L'adjonction d'une fonction de règlage de gain vidéo a nettement amélioré la qualité visuelle de l'information livrée par MARINE-VUE et a permis d'exploiter le radar de bord en mode impulsion courte haute résolution (au prix, il est vrai, d'une atténuation du signal). Cette constatation a mis en évidence l'importance de réduire la longueur d'arc de l'impulsion radar pour améliorer la définition des échos de glace de mer sur l'écran radar. Le régulateur de sensibilité temporisé a été efficace sur une distance de un mille marin seulement, la définition des échos de glace devenant nulle ou quasi inexistante au-delà de quatre milles marins. Il est recommandé de rechercher des méthodes permettant d'améliorer le pouvoir séparateur en distance du système MARINE-VUE.

Contrairement au perfectionnement du MARINE-VUE, que les officiers de navigation du N.M. Arctic ont bien accueilli, les fonctions évoluées de détermination du point sur système STAR-VUE n'ont été que peu exploitées lors de ce périple. Bien que ces fonctions du STAR-VUE aient été accessibles pendant une partie du périple, les officers du N.M. Arctic se sont montrés réticents à les utiliser, préférant se servir de la sortie imprimée fournie par ce système pour leurs

décisions tactiques de navigation dans les glaces. La réticence affichée chez les officiers était liée à un ensemble de facteurs: période de formation/familiarisation trop courte, trop grande complexité des manipulations au regard de la simplicité de la fonction assurée et faible fiabilité fonctionnelle. Le système STAR-VUE a cessé de fonctionner au retour de Nanisivik de sorte qu'il n'a pas été disponible pendant la majeure partie des essais en mer. Compte tenu de la réaction des officiers du N.M. Arctic à l'endroit du système STAR-VUE, il est recommandé d'établir des programmes de définition des tâches et de formation des navigateurs appelés à utiliser des technologiques de navigation de pointe. De plus, il est recommandé de perfectionner le processeur STAR-VUE de manière à lui donner des capacités de traitement de données adaptées aux exigences des matériels actuels et futurs.

Field Evaluation of TDC/Intera MARINE-VUE Upgrades Final Report

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1.0 Introduction:

Canarctic has recently completed the five-year Shipboard Ice Navigation Support System (SINSS) development program. The purpose of the five-year SINSS program was to develop an ice intelligence system onboard the M.V. Arctic which would enable the vessel to safely and efficiently navigate through heavy sea ice conditions. The SINSS program resulted in the specification of a first generation ice navigation system comprising strategic satellite information (VIEWFAX), a strategic and tactical airborne radar imagery display system (STAR-VUE), and a tactical and close range ice hazard detection marine radar system (MARINE-VUE).

One of the most significant deficiencies identified by Canarctic with the first generation SINSS lay with the marine radar component of the system. It had been found, by Canarctic, that MARINE-VUE lacked a number of required features including an active range and bearing cursor combined with a high quality bright CRT display that had proper image enhancement capabilities. To address these deficiencies, Intera Technologies Ltd. completed, on behalf of the Transportation Development Centre, a number of upgrades to the software and hardware of the marine radar component of the ice navigation system. This report presents the results of an intensive field evaluation of these upgrades by Canarctic during the November, 1988, commercial voyage of the M.V. Arctic to the Nanisivik mine on northern Baffin Island.

1.1 Project Objective

There were two objectives completed for this project:

1) To undertake the initial field evaluation of the MARINE-VUE upgrades under operational conditions; and

2) To collect representative SAR and marine radar pairs of the ice conditions in Lancaster Sound and northern Baffin Bay using Canarctic's TK-50 cassette tape drive and the new software developed by Intera as part of the TDC program, for future analysis.

2.0 Methods:

2.1 Equipment Installation

2.1.1 MARINE-VUE

The marine radar component of the Shipboard Ice Navigation Support System (SINSS) field tested for this project varied significantly from previous installations used onboard the vessel in the past. The MARINE-VUE installation tested during the November, 1988, field trial voyage consisted of the following components:

1) Vessel's "X" Band DECCA radar system
2) Canarctic Radar Display Selector
3) Intera Radar Video Processor
4) Intera MARINE-VUE Control Panel
5) Lemcule Stepper to Synco Gyro interface
6) FOLSOM Radar Scan Converter
7) Hitachi RBG Monitor

Figure 2.1 is a block diagram of the MARINE-VUE system as field tested. The major additions to MARINE-VUE over the system tested previously were the Radar Video Processor, the MARINE-VUE Control Panel as well as hardware modifications to the FOLSOM radar scan converter.

2.1.1.1 DECCA Radar System

The MARINE-VUE system was driven by the vessels main DECCA "X" band marine radar, model number AC/G296. The radar has a power output of 25 kw driving a nine foot antenna producing negative log video with a 18 MHZ maximum band width. The video and trigger signals were fed to the MARINE-VUE system via the Canarctic Radar Display Selector.

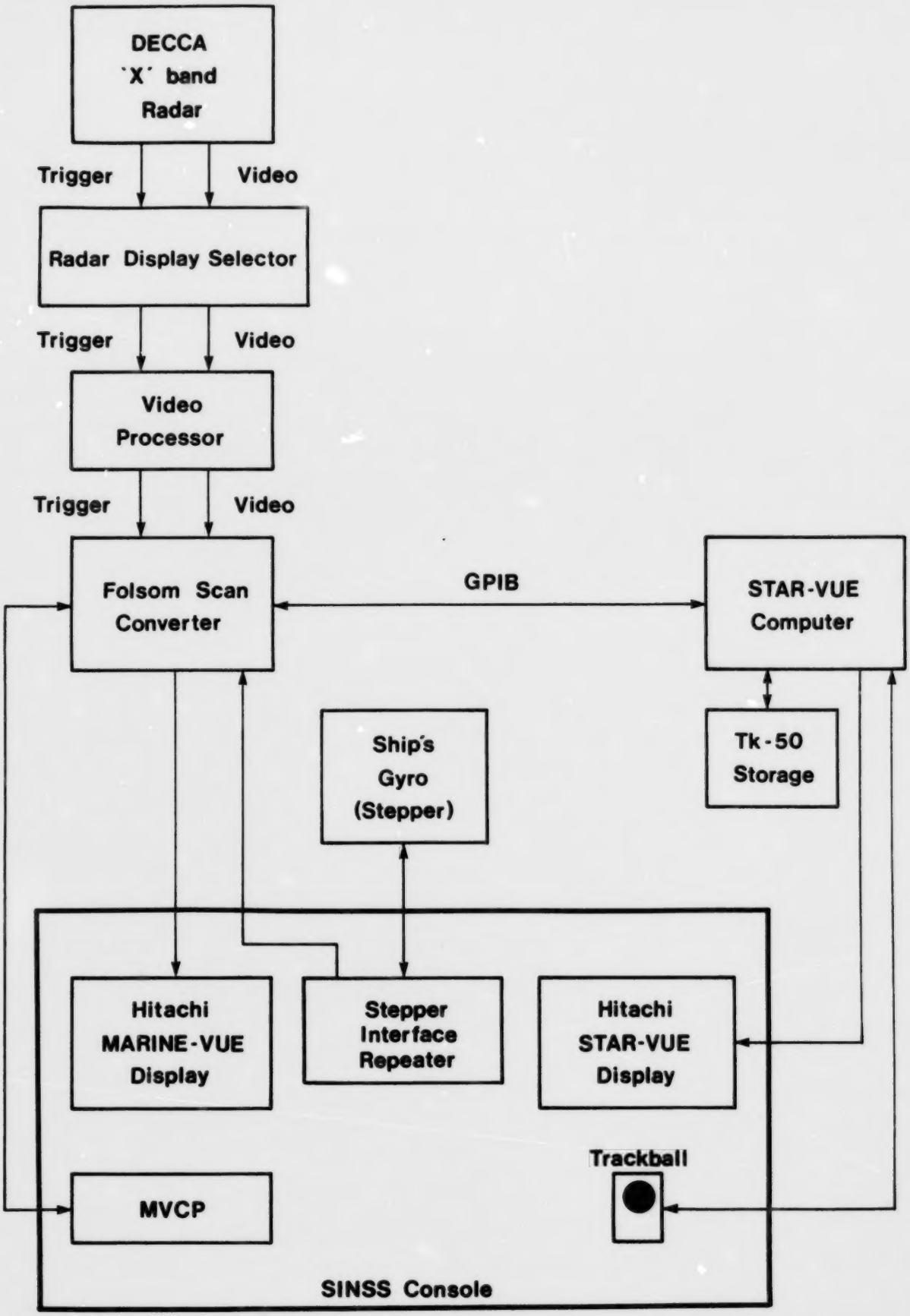

Figure 2.1: MARINE-VUE Block Diagram

2.1.1.2 Canarctic Radar Display Selector (RDS)

The RDS is a radar signal multiplexer designed to accept the signals from up to four marine radar systems to be displayed on four separate display devices. The RDS processes all signals needed by a radar display to perform as a repeater. These are: synchro (R1, R2, R3, Ref), video, trigger and heading marker. All outputs are buffered from the input signal. One of the outputs has been configured to be compatible with the JRC format (4 KHz resolver, positive video) and one input is configured to accept Sperry standard signals (60 Hz synchro). The remaining two inputs as well as three outputs are configured to comply with the DECCA standard (400 Hz synchro, negative video).

For the purpose of the MARINE-VUE field trial described here, the DECCA radar input to the RDS was transferred and buffered via the RDS and was output to the Intera Radar Video Processor.

2.1.1.3 Intera Radar Video Processor

The Radar Video Processor (VP) receives the input analogue radar video and trigger information from the vessel's DECCA "X" band marine radar via the RDS. The VP alters the radar video signals according to commands received from the MARINE-VUE control panel. The following parameters are modified by the VP:

Name	Function Performed	min	max
Video Offset	adds a DC offset to the radar signal	-1 VDC	+1 VDC
Video Gain	applies gain to the radar signal	-10 dB	+10 dB
STC Threshold	selects STC curve	--	--
STC Time Constant	selects range endpoint for STC equalization curve	0.5 nmi	4.0 nmi
FTC	selects band-reject filter ON or OFF	--	--
Video Blanking	disables video data of one radar while the other is transmitting	1.5 US	10 US

The sensitivity time constant (STC) is applied to the marine radar image to reduce near range saturation and boost returns in the far range of the display to equalize the radar returns. Eight different STC curves are available for selection via the MVCP. Details of these curves may be found in Intera (1988). The STC time constant selects the end point for the equalization curve.

The fast time constant (FTC) is a low-band reject filter which performs an anti-rain clutter function for the MARINE-VUE system.

2.1.1.4 Intera MARINE-VUE Control Panel

The Intera MARINE-VUE control panel (MVCP) enables the operator to control the functions of the video processor and FOLSOM Scan Converter remotely at the SINSS console. Through the operation of numerous dials and push buttons, the operator inputs desired commands to the MVCP which, in turn, sends the parameter changes to the Video Processor or Scan Converter over serial communication lines. Figure 2.2 is a photograph of the MVCP. The MARINE-VUE functions undertaken by the Video Processor which are altered at the MVCP are:

1) Offset - the video signal baseline
2) Gain - increases or decreases the intensity of the received radar signal to adjust contrast on the image.
3) STC Threshold - selects one of eight STC curves to provide equalization of the radar signals.
4) STC Time Constant - selects the end point for the STC equalization curves.
5) FTC - engages the anti-rain and snow filter.

The functions of the radar scan converter altered by the MVCP are:

1) Display mode selectable between:
   a) Variable - will orient the marine radar display to "STAR-VUE up" , that is, the marine radar display will be oriented with the azimuth of the SAR flight line at the top of the display.

   b) North-up - displays the marine radar in "north-up" mode.

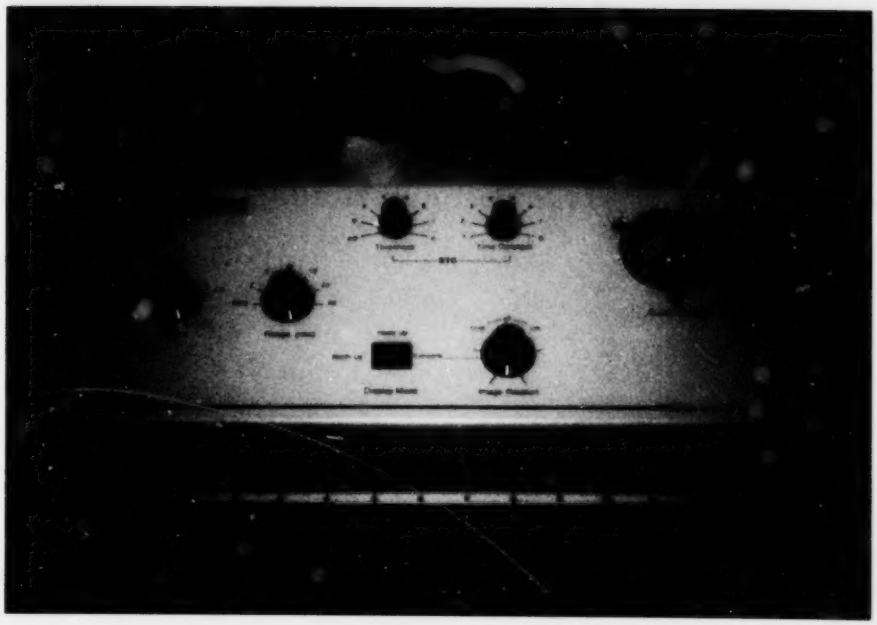

Figure 2.2: MARINE-VUE Control Panel

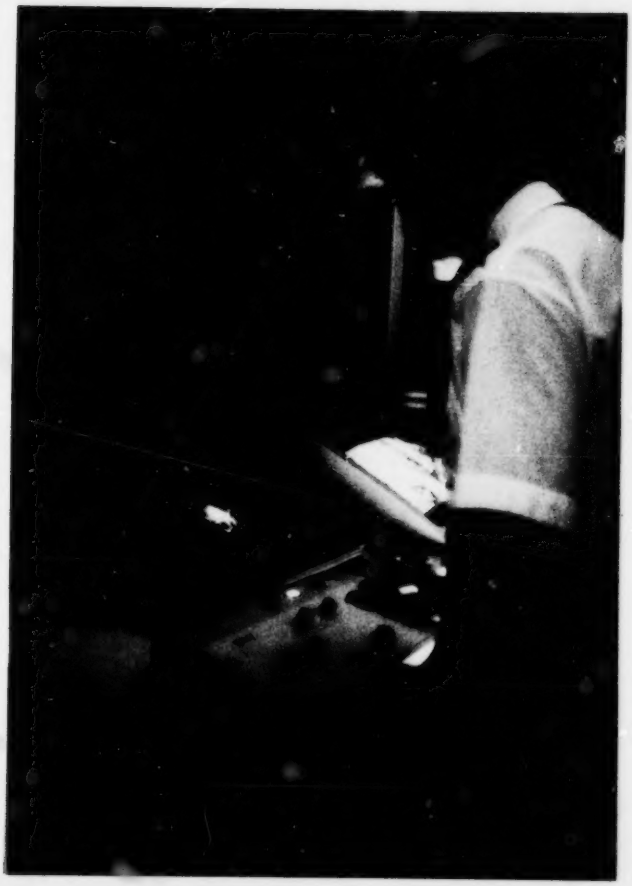

Figure 2.3:

Master utilizes MARINE-VUE SINSS console.

c) Head-up - displays the marine radar image in the ship's "head-up" mode.

2) Image Rotation - when the variable mode is selected, the function allows the marine radar display orientation to be adjusted by a turn of a dial to compensate for ice motion.

3) Range - selects the marine radar range from 2 miles to 48 n.mile range. In the "Auto" setting, the range is selected to match the scale of the radar image displayed on STAR-VUE (6.6 n.mile for 24 m resolution).

4) Overlay - enables/disables the azimuth and range rings as well as heading marker and scan converter overlay block from the MARINE-VUE display.

5) PPI Origin - allows the centre of the marine radar image to be re-displayed where the active range and bearing cursor is located.

6) PPI re-set - re-set the origin to centre.

7) Cursor control - allows an active cursor to be moved on the MARINE-VUE display via the track ball.

2.1.1.5 Lemicule Gyro Repeater

The standard gyro output from the DECCA radar system is produced using a stepper motor. In order for the signal to be processed by the micro-processor of MARINE-VUE, the gyro output needed to be re-configured into syncro format. The stepper to gyro interface is undertaken by a Lemcule Gyro repeater. This unit, which also displays the ships heading in digital format, was mounted on the SINSS console between the MARINE-VUE and STAR-VUE screens.

2.1.1.6 FOLSOM Radar Scan Converter

The analogue to digital conversion of the marine radar signal is undertaken by the FOLSOM model 8342 Radar Scan Converter. The scan converter receives the radar video and trigger information from the Intera Video Processor. The scan converter digitizes radar vector video, trigger and azimuth data through a 6 bit A/D flash converter which is in turn written into a 512 x 512 x 9 bit memory. The resultant digitized radar video has 6 bits representing 64 levels of digital resolution. The remaining 3 bits of image memory are reserved for overlay planes for graphics, cursors and annotations.

The scan converter incorporates the gyro information from the Lemcule gyro repeater and commands from the MVCP via RS-232 cables. The scan converter serves as the interface between the MARINE-VUE system and STAR-VUE (see section 2.1.2) via a General Purpose Interface Bus (GPIB). The scan converter drives the MARINE-VUE video monitor via a three cable RGB output.

The FOLSOM Radar Scan Converter, Intera Video Processor and Canarctic Radar Display Selector were mounted in the SINSS

electronic equipment rack on the bridge. The Lemcule Gyro Repeater, Hitachi Monitor and MARINE-VUE Control Panel were mounted at the SINSS prototype navigational console. Figure 2.3 is a photograph of the Master of the M.V. Arctic utilizing the MARINE-VUE control panel during the voyage at the SINSS console.

2.1.2 STAR-VUE

The reception and display of downlinked digital SAR imagery from the Intera STAR-1 system is undertaken utilizing the STAR-VUE system onboard the vessel. The STAR-VUE system remained largely unchanged from that used previously onboard the vessel and described in Intera, (1987) and Canarctic, (1988a).

The major upgrade to the STAR-VUE system undertaken on behalf of the MARINE-VUE upgrades was the development of vessel position fixing capabilities on the SAR imagery. This upgrade, which allows the operator to mark a ships position on STAR-VUE based on the analysis of the MARINE-VUE display was developed by Intera as a result of recommendations from previous field trials of STAR-VUE by Canarctic (Canarctic, 1988a).

The vessel position software was added to the STAR-VUE system as an additional sub-menu option using the course and distance menu. The options available under the new "confirm ships position" menu are:

2.1.2.1 Query MARINE-VUE

This function is used to generate the "triangulation" position fix on STAR-VUE. Under the manual method of position fixing using the hard copy SAR film, identifiable features on the marine radar display (such as distinct ice floes, leads etc) are also identified on the SAR film. The position of the vessel is then marked on the

SAR film by measuring the range and bearing (using the active cursor on the marine radar PPI display) to each feature then, using a ruler and compass the same distance and bearing is measured on the SAR film to identify the vessels position. The vessel's position and the UTC time is then marked on the hard copy film using a pen.

The primary purpose of the STAR-VUE upgrades was to emulate this procedure on STAR-VUE. The "Query MARINE-VUE" option operates by the user first selecting this menu option using the track ball and cursor after which STAR-VUE prompts the user to identify a feature present on both the MARINE-VUE and STAR-VUE displays. For example, if a distinctly shaped ice floe is visible on the marine radar that is also identifiable on the SAR display of STAR-VUE, the operator moves the cursor on the MARINE-VUE to the feature as well as the STAR-VUE cursor to the same feature on the SAR display. Once these are selected, the Query MARINE-VUE function is activated and the STAR-VUE system captures, via the GPIB interface, the range and bearing information from MARINE-VUE and uses the information to calculated and draw a vector line on the SAR display away from the identified feature. The end point of the line should be near where the estimated position of the vessel should be. The function is called triangulation as usually three positions are needed to focus in on an accurate position.

2.1.2.2 Mark Ship's Position

Once the triangulation fixes are calculated, the "Mark ships position" function draws a connecting line to the previous marked position to trace the travelled course of the vessel along the SAR film. Essentially, this function utilizes the "Actual route" option of the course and distance menu.

2.1.2.3 Comment Option

This option allows the operator to enter the UTC time as well as textural comments next to each marked position. A pop-up key pad is activated by this function for this purpose.

2.1.2.4 Centre Ship in Image

This function uses the last marked ships position to move the overview and detailed SAR display so that the ships position is displayed in the centre of the screen. The benefit of this function is to speed up the process of moving along the SAR display so that the operator will not have to return to the "View Image" menu each time the SAR image needs to be advanced.

2.2 Field Trial

The field trial evaluation of the TDC/Intera MARINE-VUE upgrades took place during the last high Arctic voyage of the M.V. Arctic to Nanisivik for 1988. The MARINE-VUE functional evaluation undertaken during this field trial was composed of the following points:

1) Test the accuracy of the triangulation position fixing function on STAR-VUE relative to the position of the vessel identified on the MARINE-VUE display (ie. how close to the actual position can the STAR-VUE position be fixed).

2) The improvement to the quality of the marine radar video display as a result of the use of the STC function and gain and threshold controls on the MARINE-VUE control panel were assessed. A series of 35 mm photographs of the MARINE-VUE image were collected recording the

improvements. (Appendix C).

3) The accuracy of the active range and bearing cursor on the MARINE-VUE display was compared to the PPI display of the vessel's marine radar.

4) SAR/marine radar digital pairs were recorded onto the TK-50 cassette tape drive of the Canarctic STAR-VUE when representative radar fixes on the SAR were established.

The final voyage of the season occurred between November 1, and November 23, 1988, as the vessel sailed between Nordenham, West Germany, Nanisivik, N.W.T. and Belledune, N.B. Table 2.1 presents a summary of events for the field trial evaluation of the MARINE-VUE upgrades.

Table 2.1

MARINE-VUE Field Trial

Schedule of Events

November, 1988

Date/Time	Vessel Location	Project Action
October 27 p.m.	-	Test Personnel depart Canada
October 28 a.m.	-	Test Personnel arrive in Nordenham West Germany
October 30 a.m.	M.V. Arctic arrives at Nordenham and begins cargo discharge	Test Personnel board vessel and MARINE-VUE hardware is installed and tested.
November 1 a.m.	Vessel completes discharge and departs Nordenham enroute to Nanisivik	-
November 1-11	Enroute across North Atlantic Ocean to Northern Baffin Bay	Flight plan for STAR-1 developed and schedule co-ordination with Intera maintained
November 11 a.m.	Vessel arrives in Northern Baffin Bay	First downlink of STAR-1 SAR received onboard vessel (app. 6 hrs) SAR data recorded onto STAR-VUE and tactical film products produced (2 hrs)

Table 2.1 con't

		tactical route selected on imagery
Nov. 11-12	Vessel navigates through ice of Lancaster Sound using SINSS	continous monitoring of vessels progress on SAR maintained by using MARINE-VUE
		position fixes noted on STAR-VUE and MARINE-VUE are saved and recorded on TK-50 cassettes throughout period
		MARINE-VUE functional evaluation undertaken
		Second SAR flight received in evening of Nov. 11 near entrance to Admiralty Inlet
Nov. 12-14	Vessel docks at Nanisivik and loads lead-zinc cargo	project review undertaken with TDC project officer on status of evaluation
		Intera and TDC representative depart vessel

Table 2.1 con't

Nov 15	Vessel completes loading operations and departs	Six hours prior to departure of vessel from dock, STAR-1 SAR downlink received onboard vessel SAR data recorded onto STAR-VUE and tactical film products produced tactical route of vessel selected on imagery
Nov. 15-16	Vessel navigates through ice of Admiratly Inlet and Lancaster Sound using SINSS	Continuous monitoring of vessel progress on SAR as per inbound process position fixes noted on STAR-VUE and MARINE-VUE and data recorded as per inbound voyage MARINE-VUE functional evaluation continues

Table 2.1 con't

		second SAR flight received in afternoon of Nov. 15
Nov. 16 a.m.	Vessel exits heavier ice area and SINSS use stops	All data acquisition catalogued and filed
		review of STAR-VUE and MARINE-VUE systems status undertaken. Trouble areas identified.
		Equipment securred
Nov. 23	Vessel arrives Belledune N.B.	Project personnel depart
		Project personnel return to Ottawa with
		TK-50 cassettes and data logs. Field trial complete

3.0 Results - Voyage Summary

3.1 Pre-Voyage Preparations

The M.V. Arctic arrived at the Port of Nordenham, West Germany, in the morning of October 30, 1988, to discharge cargo and begin preparations for the final Arctic voyage of the 1988 shipping season. The MARINE-VUE hardware components, to be tested for this program, were installed and checked by Intera, Canarctic and TDC representatives. The difficulties encountered earlier in the season with the MARINE-VUE component (Appendix "A") were investigated while in port and the results of this investigation are the subject of a separate report (Appendix "B").

At the completion of the installation and testing, the MARINE-VUE components were found to be functioning properly except for the FOLSOM radar scan converter. The difficulties encountered with the scan converter occurred in two areas:

1) The scan converter was incapable of dealing with the higher PRF (Pulse Repetition Frequency) generated by the vessel's DECCA radar system and,

2) An inoperative colour video board as a result of design or implementation errors.

The PRF problem was overcome by building a circuit to eliminate one in two synchronization pulses from the radar thus reducing the PRF sufficiently from 3.3 KHz to 1.5 KHz thus allowing proper functioning of the scan converter. This solution did not degrade the radar image display in any way. The colour video board malfunction did not affect the objectives of the MARINE-VUE field evaluation as a monochrome display was all that was required for this project.

3.2 Inbound Voyage

The M.V. Arctic departed the port of Nordenham in the early evening of November 1, 1988. During the ocean crossing, the schedule of the tactical SAR aircraft mission was finalized with Intera. In addition, the entire SINSS hardware system, including STAR-VUE and MARINE-VUE were checked. All functions on the MARINE-VUE system were found to be operating properly but minor problems were encountered with STAR-VUE. The first problem encountered was the inability of the STAR-VUE system to create and save a defined region (the large scale blow-up of the world map to display planned SAR coverage). This was a minor problem and did not impair the operation of the system. The second difficulty encountered was that the actual and planned route segments in the course and distance menu did not connect to the planned way points but were offset by several pixels. This difficulty slightly impairs the functionality of the operation since a planed route segment does not follow the preferred route selected but, rather, would draw through ice floes planned to be avoided.

While enroute to the Canadian Arctic, strategic information on the ice conditions enroute to Nanisivik were derived from VIEWFAX NOAA thermal infra-red satellite images and AES current ice charts prior to the first tactical mission. The ice conditions which existed in northern Baffin Bay and Lancaster Sound during the inbound voyage consisted of 9 plus tenths grey white ice and thin first year ice with areas of moderate to heavy ridging. The first SAR downlink occurred at 14:45 UTC November 11, 1988, while the vessel was making good progress in 9 plus tenths grey white ice in northern Baffin Bay near 7350N, 7400W.

Soon after the STAR-1 downlink began, data reception difficulties were encountered by STAR-VUE. The scaling factor of the imagery appeared stretched in the "Y" axis on the real-time

waterfall display. After the second complete line of data was received, the receiver interface of STAR-VUE went into error and could not record any more of the downlinked data onto the hard disk. Fortunately, the real time dry silver film copy continued to be received at the proper scale and image intensity. Unfortunately, the loss of the digital data from the STAR-VUE hard disk meant that the new confirm position functions on STAR-VUE could not be tested on the first downlink mission and that the MARINE-VUE/STAR-VUE "pairs" collected would not have the STAR-VUE SAR image component. However, when each MARINE-VUE image was collected, the location of the vessel was fixed on the concurrent hardcopy SAR film such that the digital SAR data could be re-created from the aircraft tape if required.

Despite the failed attempt at SAR data reception onto STAR-VUE, the inbound voyage allowed for a rigorous test of the new MARINE-VUE system. The M.V. Arctic made good progress through the grey-white and thin first year ice of Lancaster Sound and the SAR imagery was used to avoid a large area of heavily ridged first year ice in the centre of Lancaster Sound. A second downlink of tactical SAR imagery was received in the evening of November 11, 1988, as the vessel neared the entrance to Admiralty Inlet in Lancaster Sound. Unfortunately, the received downlinked SAR data suffered from the same distortions in the "X" axis as the first mission. The second mission was of a short duration being comprised of two short (80 n.miles each) lines covering Lancaster Sound north of Admiralty Inlet. Due to the short duration of the mission, all SAR data was received by STAR-VUE without the system failing, all be it in a distorted format.

The received SAR imagery of the second downlink mission was used to direct the vessel into a series of leads in northern Admiralty Inlet. The M.V. Arctic arrived at the Port of Nanisivik in the morning of November 12, 1988, having made a successful

transit of Lancaster Sound. In total, 64 digital marine radar images were saved via the new "back-up radar pairs" functions and stored onto four TK-50 cassette tapes. These marine radar images give a near complete marine radar set concurrent with the hardcopy SAR imagery of the ice conditions transitted during the inbound voyage to Nanisivik. Details on these pairs can be found in the MARINE-VUE pairs log included under separate cover as Appendix "C".

3.3 Outbound Voyage

The problem encountered during the inbound voyage with STAR-VUE data reception was investigated while the vessel loaded at Nanisivik. It was determined, based on discussions with Intera from Nanisivik, that the problem lay with the line averaging assigned in the receive data parameter file of STAR-VUE. For some unknown reason, the line averaging had inadvertently been changed at some point prior to the voyage from the required 3 to 1, a parameter that should not normally be altered. Thus, the received data files were three times longer than they should have been which resulted in the failure of STAR-VUE to capture the downlink during the inbound voyage. The parameter file was inspected prior to the start of the downlink but no documentation was available onboard the vessel to aid in identifying what settings should have been used. The parameter file was corrected prior to the start of the outbound voyage.

The outbound tactical SAR downlinks occurred in two stages. The first mission occurred two hours prior to the departure of the vessel from Nanisivik in the early morning of November 14, 1988. However, this mission had to be abandoned after the first flight line due to excessive data drop outs and limited downlink range caused by the high mountains surrounding Strathcona Sound. The M.V. Arctic departed the Nanisivik dockside in the early morning of November 15, 1988. The second downlink mission occurred at

14:25 UTC, November 15, 1988, as the vessel entered Lancaster Sound. Four tactical SAR lines were received without any difficulties and were properly scaled. Therefore, the outbound voyage provided a good opportunity to test the new confirm position menu of STAR-VUE and the auto scale and auto-orient functions of MARINE-VUE.

The ice conditions for the outbound voyage were similar to the inbound voyage being comprised of grey-white and thin first year ice with areas of heavy ridging. However, strong southerly winds during the two days the vessel loaded had opened several large east-west leads north of Admiralty Inlet. These leads showed up clearly on the SAR imagery and the vessel exploited the leads eastward to north of Navy Board Inlet. The vessel altered course north of Navy Board Inlet to the north-east to avoid heavy ridging north of Bylot Island visible on the SAR imagery. The M.V. Arctic made slow progress north of Bylot Island due to heavy first year ice and ridging in the area. The SAR imagery was used to tactically avoid the heavier ridge areas and the vessel was accurately placed on the imagery until the morning of November 16 when the vessel entered northern Baffin Bay. The imagery remained accurate until the vessel sailed beyond the eastward extent of the coverage 20 hours after reception.

As the vessel navigated through the ice conditions of Lancaster Sound, the new upgrades to the MARINE-VUE and STAR-VUE systems were extensively tested (the details on the findings of this test are found in the next chapter). Throughout most of the tactical exercise, the real time hard copy film was used and it was found that, since the orientation was easier to manipulate, it became being the preferred choice of the navigating officers over STAR-VUE for floe by floe tactical navigation.

After several hours of using the MARINE-VUE - STAR-VUE upgrades during the outbound voyage, several serious failures began to occur on STAR-VUE. The failure renders the system unusable for the remainder of the outbound voyage. Details on the nature of these failures are presented in Section 4.3.2 in the next chapter.

4.0 Discussion - MARINE-VUE/STAR-VUE Evaluation

The evaluation of the Intera/TDC upgrades will be divided into two distinct components: those which deal with the improvements to the MARINE-VUE video display and those dealing with the STAR-VUE/MARINE-VUE vessel position determination.

4.1 MARINE-VUE Video Display Enhancement

The most important improvement to the shipboard ice navigation system which occurred as a result of the MARINE-VUE upgrades was the enhancement of the MARINE-VUE display. The upgrades which improve the video display will be evaluated in this section.

4.1.1 Video Gain

One of the most fundamental controls required from a marine radar display is the ability to control the amount of video gain sent to the display device. In high radar clutter environments, the ability to control the gain enables the operator to reduce the video signal to highlight important signal. In low clutter or weak signal backgrounds the gain setting allows the operator to boast the video signal to identify weak returns.

The video gain settings are critical when dealing with sea ice on a marine radar display. Due to the usually low relief of sea ice (relative to ships or shorelines) and the relatively shallow incident angles of a marine radar, sea ice returns tend to be some of the lowest on a marine radar display. Therefore, the ability to add gain to the signal greatly improves the detectability of sea ice.

During previous field trials of bright (daylight) marine radar displays using the FOLSOM radar scan converter (and RIDS

previously) the lack of an ability to adjust the video signal gain was identified as a serious limitation. The gain settings on the MARINE-VUE system have been designed such that the video signal may be decreased to -10db, or increased to +10db. Throughout most of the field trial, the video gain was used in the +2 to +3 db range. Turning the gain any higher resulted in blooming and saturation of the display. On occasion, the gain was reduced to near zero to highlight details within heavily cluttered areas.

The effect of the use of gain control on the quality of the marine radar image can be seen in Figures 4.1 and 4.2. Figure 4.1 is a photograph of the MARINE-VUE display with no gain added to the video signal. Figure 4.2 is a photograph of the same MARINE-VUE scene with a gain of +3 db. The ability to detect ice features in the far range is much improved in Figure 4.2 than 4.1 due to the use of the gain adjustments. It is also clear that increasing the gain has the effect of increasing the near range saturation and this is dealt with in Section 4.1.2.

In general, the range of settings available on the gain control were more than adequate for the purpose and no alterations are required.

4.1.2 STC Threshold and Time Constant

A typical marine radar image consists of a saturated display within the first nautical mile of range with the signal strength decreasing markedly with increased range. The sensitivity time constant (STC) is applied to the marine radar image to reduce near range saturation and boost returns in the far range of the display to equalize the radar returns. Eight separate STC curves are selectable via the MARINE-VUE control panel. The STC time constant selects the end point for the equalization curve.

Figure 4.1:

MARINE-VUE display with no video gain added to image.

Figure 4.2:

Same image as 4.1 with +3db gain added to video signal. Note higher definition in far ranges but increase is near range saturation.

Figure 4.3:

Same image as 4.2 but with STC Curve applied. Note decrease in clutter within first nautical mile of range.

The STC curves were effectively used during the voyage to reduce the amount of near range clutter on the MARINE-VUE display. Figure 4.3 is a photograph of the MARINE-VUE display with the STC threshold and time constant functions fully applied. Figure 4.2 was the same image with the function not applied. The differences between Figure 4.2 and 4.3 are subtle, primarily occurring within the first nautical mile of range. However, from Figure 4.3 it is clear that the vessel was navigating through an ice floe, a fact not discernable from Figure 4.2. Consequently, when the gain was turned up on the video display to highlight significant ice features, the STC function was a valuable tool to reduce the resultant near range saturation.

Since the effect of the STC curve was subtle, occurring only within one nautical mile of range, the effect of using a different curve was minimal. It was found that, although eight different STC curves were available, the difference between each curve was minimal to non-existant on the video display. It would appear that the mathematical variation between each curve is not as great as possibly is required. In addition, the STC curves had no effect on the video signal beyond one nautical mile and thus, do not have an effect on improving the video signal in the far ranges of the display.

4.1.3 Fast Time Constant (FTC)

The fast time constant is a low-band reject filter which acts as an anti-rain clutter for the MARINE-VUE system. Throughout the fall voyage field trial rain or snow squalls were not a factor in interfering with the radar display. Therefore, a full test of this function could not be undertaken. Figure 4.4 is a photograph of the MARINE-VUE display without the FTC filter applied and Figure 4.5 is a photograph of the same scene with the FTC filter on. The FTC filter has the effect of corrupting the MARINE-VUE display with

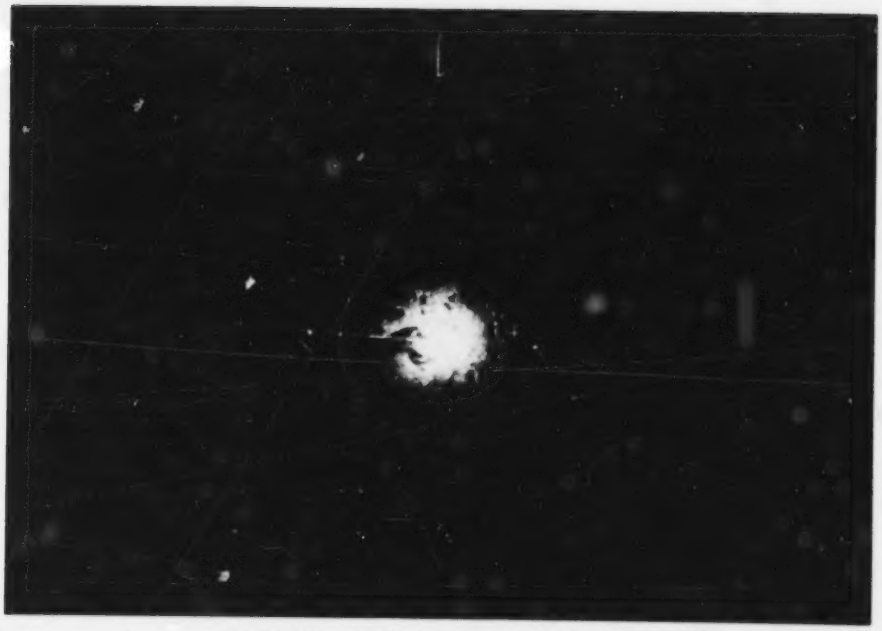

Figure 4.4: MARINE-VUE image with FTC off. Gain set to +2.5, STC threshold 3, STC time constant 6.

Figure 4.5: Same image as 4.4 with FTC function applied.

a high level of noise clutter, thus defeating the purpose of the filter. Since the high pass cut-off frequency of the filter may be altered between 40 KHz and 120 KHz via an internally mounted potentiometer, it is likely that some adjustment is required here.

4.1.4 Display mode

The display mode selector on the MARINE-VUE control panel (MVCP) allows the operator to display the marine radar image in north-up, heads up or variable format. When the variable format is selected, the marine radar display is oriented to STAR-VUE up, that is, the marine radar display will be oriented with the azimuth of the SAR flight line at the top of the display. It had been found, during previous field trials of shipboard ice navigation systems (Canarctic, 1987a, 1987b) that it was critical to have the marine radar image and SAR image oriented in the same direction in order for the pattern recognition process between the two to be possible. With the hard copy product, it was a simple process of orienting the SAR on the light table to match the north-up marine radar display. However, with the SAR video display of STAR-VUE fixed in the "flight line" up mode, the marine radar image of MARINE-VUE must be altered to the SAR on STAR-VUE and this is accomplished using the "variable" function of MARINE-VUE.

The display mode switch operated effectively on the MVCP with the resultant effect being readily seen on the MARINE-VUE display.

The operational mode of the marine radar on any vessel navigating at sea is in north-up mode. Therefore, the master, ice pilot and navigating officers of the M.V. Arctic are accustomed to viewing the radar display in this mode. Therefore, during the field test voyage when the MARINE-VUE display was selected to the variable mode to match STAR-VUE, the tendency of the officers was to select the north-up mode and to use the available hard copy SAR

product instead of STAR-VUE for the floe by floe position determination. The difficulty stems from the confusion caused by viewing the vessels PPI display in "north-up" for vessel conning then moving to the SINSS console to view the radar display which is a completely different orientation. It is clear that the SINSS orientation will have to match that of the conventional radar to avoid confusion.

4.1.5. Radar Range Setting

The MARINE-VUE display may be set in range from 2,3,6,12,24 and 48 n.mile ranges. In addition, an option is available to "auto scale" the marine radar image to match that on STAR-VUE. That is, for the 24 meters high resolution display of SAR on STAR-VUE, the MARINE-VUE system will automatically be set to 6.6 n.mile range (via a command from the GPIB from STAR-VUE). For the 48 meter resolution SAR display, MARINE-VUE is automatically set to 13.3 n.mile range. The theory behind this option is that the scale of the MARINE-VUE image would match that of STAR-VUE such that a floe identified on the MARINE-VUE display would appear the same size on the SAR display. When the auto scale is used in combination with the auto orient, the MARINE-VUE image should emulate the STAR-VUE display in floe size and orientation thus, in theory, easing the pattern matching process.

In practise, the most effective range to set the MARINE-VUE system, as found during vessel navigation in ice is 3 n.miles. Beyond 4 n.mile range vertually no sea ice returns are visible on the marine radar display. Therefore, when the auto scale function on MARINE-VUE was selected, the range of MARINE-VUE was set to a range much further than any useful ice returns were being generated. Figure 4.6 is a photograph of the MARINE-VUE display with the range set to the 3 n.mile range used operationally during the voyage. Figure 4.7 is a photograph of the same display with

the range set to auto scale to STAR-VUE at 24 meters SAR resolution (6.6 n.mile range). Clearly, much of the display is not being effectively used with only the largest of ice features being identifiable on the radar display. Figure 4.8 is a photograph of a different radar screen set to auto scale to STAR-VUE at 48 meters SAR resolution (13.3 n.mile range). As can be seen, very little useful ice information can be extracted from this radar image at this range. Due to the above limitation, the auto scale function (like the auto-orient function) were not used by operational personel during the voyage.

4.1.6 Curser Control and Image Overlay

In addition to radar video processing functions, the new MARINE-VUE upgrades also included an active range and bearing cross-hair cursor as well as range rings and ships heading marker. Figure 4.6 illustrates the overlay functions as displayed on MARINE-VUE. An option is available to turn off all overlay functions via a switch on the MVCP.

The navigating officer found the active range and bearing cursor to be very effective and frequently commented on the benefits of this addition. Comparative measurements between the PPI and MARINE-VUE found no discrepancies in the accuracy of range and bearing readings on MARINE-VUE. The track ball response was quick and accurate being routinely used by the officers. The range rings were found to be useful on occasion although it was suggested by the officer that an option to dis-able the interior rings (while retaining the outside ring) would be advantageous. Such an option would produce an overlay similar to Figures 4.7 and 4.8 when auto-scale is used.

Figure 4.6:

MARINE-VUE set to 3n.mile range used operationally during voyage.

Figure 4.7:

MARINE-VUE set to auto-scale to STAR-VUE at 24m resolution (6.6n.mile range).

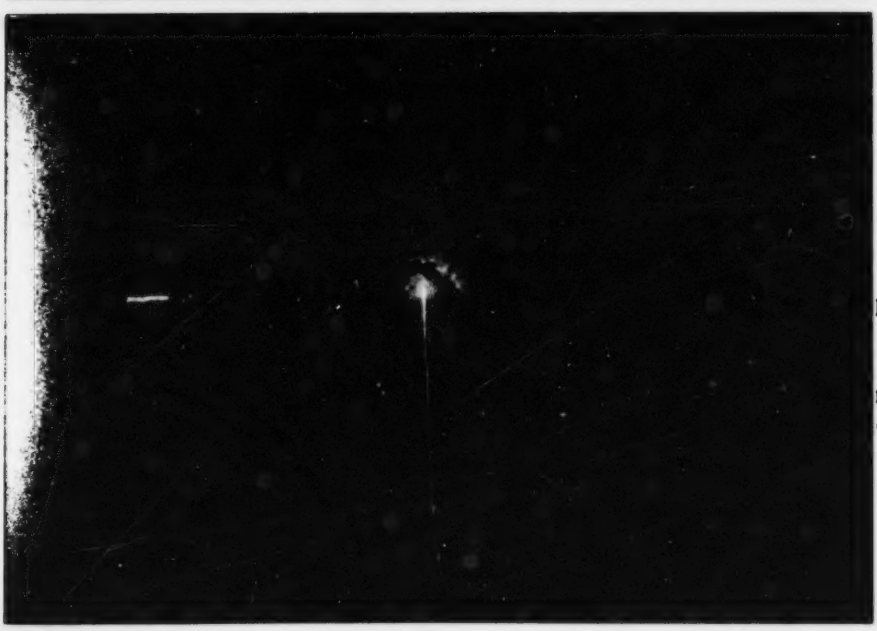

Figure 4.8:

MARINE-VUE set to auto-scale to STAR-VUE at 48m resolution (13.3n.mile range). Note that most of display not effectively used.

4.2 MARINE-VUE/STAR-VUE Position Determination

A significant component of the Intera/TDC MARINE-VUE upgrades was the addition of software upgrades to STAR-VUE to allow for a functional integration of MARINE-VUE to STAR-VUE for vessel position fixing on the SAR video display (described in section 2.1.2). Unfortunately, unlike the MARINE-VUE video upgrades which were well received by the officers, the STAR-VUE upgrades were not well received during the field trial voyage. In this section, the results of the evaluation of each upgrade as well as an explanation poor reception by the officer will be presented.

4.2.1 Query MARINE-VUE

This function is used to generate the "triangulation" position fix on STAR-VUE. The function operates by the user first selecting the option from the menu afterwhich STAR-VUE prompts the user to place the cursor at an identifiable feature on both the MARINE-VUE and STAR-VUE displays. Figure 4.9 is a photograph of the STAR-VUE screen (at 24m resolution) illustrating the Query MARINE-VUE function at the completion of the operation. The three small red arrows near the top of the display point to the position of the vessel as determined by correlating features on MARINE-VUE. Figure 4.10 is a photograph of the MARINE-VUE display set to auto orient and auto scale corresponding to the SAR of Figure 4.9. The vessel had sailed slightly to the east (bottom) of the MARINE-VUE display by the time the photograph was taken.

The Query MARINE-VUE functioned as expected but required the operator to re-select the menu option for each position line drawn. Since at least two or more such positions are typically used to confirm one position, it is recommended that the function remains active until terminated by a separate bottom on the track ball. The Query MARINE-VUE function was well designed overall for the

Figure 4.9: STAR-VUE display at 24m resolution illustrating the Query MARINE-VUE function as three red arrows at the top of the display.

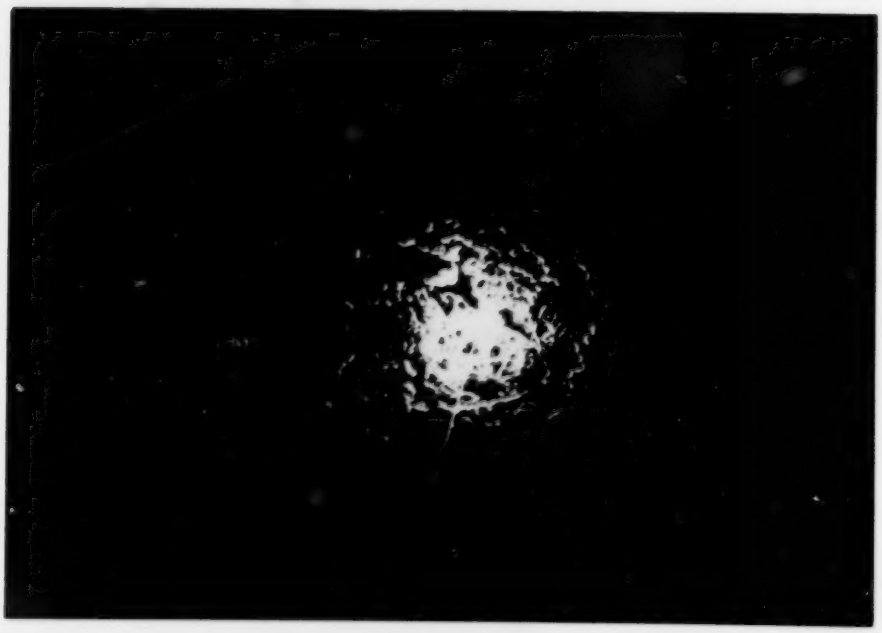

Figure 4.10: MARINE-VUE display set to Auto-scale and auto orient corresponding to STAR-VUE of Figure 4.9.

purpose intended.

4.2.2 Mark Ships Position

Once the triangulation fixes are calculated,the "Mark Ship's Position" function draws a connecting line to the previous marked position to trace the travelled course of the vessel along the SAR film. Unfortunately, the drawn line did not connect to the desired way points but were offset in the Y axis by several pixels and the X axis by one or two pixels. Clearly, a minor error exists in the software that mis-calculates the location of the cursor when drawing the actual route segment. This error is disconcerting to the operator as the line will not terminate at the location where the vessel had been placed on the SAR imagery.

4.2.3 Comment Option

This option allows the operator, via a pop-up key pad, to "time stamp" the SAR imagery as well as to add textural comments next to each marked position. When using the hard copy film, the typical procedure is to mark, with a pen, the UTC time as well as comments next to each marked position. The comments often relate to research and development activities undertaken at that point (such as photographs or data collection) or to a significant event for the ship such as a slow down or temporary stoppage. For most time marks, no comments are required. However, the comment option, as installed on STAR-VUE, required the operator to enter a textural comment next to each marked position regardless if one was required. Using the pop-up key pad, this can be a time consuming exercise. It is recommended that the entering of textural comments be a separate operation within the comment option and that a function to time stamp the SAR without comment be made available. In addition, the size of the textural information generated by the comment option whether it be UTC time or text, was extremely small

and almost impossible to read. It is recommended that the text size be increased to improve legibility. Figure 4.11 is a photograph of the STAR-VUE display showing the composite result of the triangulation function, actual plotted coarse line and time stamp on the display.

4.2.4 Centre Ship in Image

This function uses the last marked ships position to move the overview and detached SAR display so that the ship position is displayed in the centre of the screen. The use of this function allows the operator to advance the SAR imagery with a simple push of a button without having to go into the "View Image" menu to re-select more SAR imagery.

With the STAR-VUE system displaying SAR in "flight-line-up" mode, the vessel will usually be moving toward the top or the bottom of the SAR display. Therefore, it is recommended that the centre ship in image be changed to allow an option to centre ship at the top or bottom of the display depending on which direction the vessel is moving. Such an upgrade will serve to minimize the number of times the function will need to be used. Minimizing the number of time the SAR needs to be re-freshed on STAR-VUE is critical as the process is extremely slow, taking more than four minutes when the SAR is at 48 m resolution.

4.3 STAR-VUE/MARINE-VUE System Functional Evaluation

In order for new technological developments to be successful and functionally used by the navigating officers they must meet the following two criteria:

1) Improve the speed and efficiency of an operation over previous methods; and

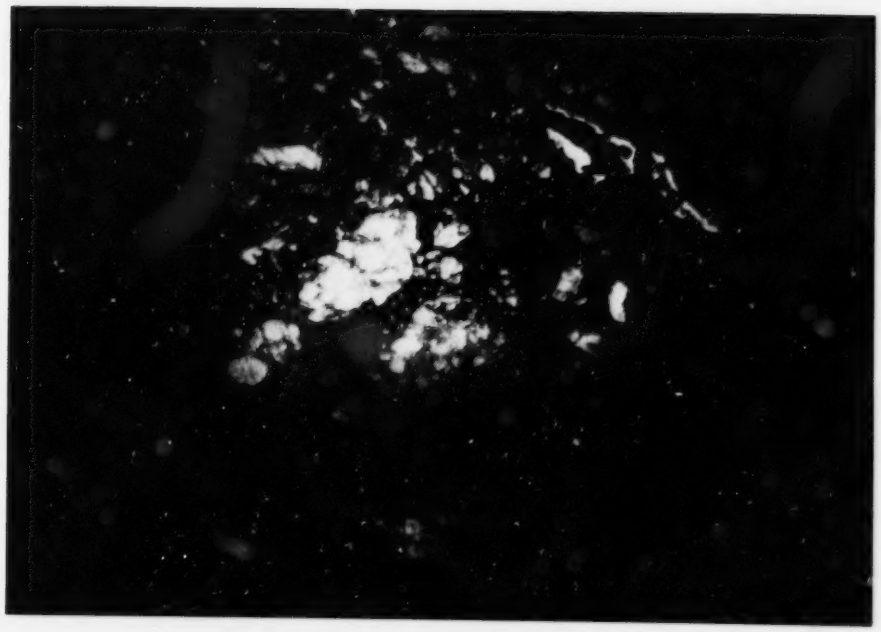

Figure 4.11: STAR-VUE display illustrating the composite result of the actual ship's route, Query MARINE-VUE and time stamp (comment) functions.

2) Allow for new and expanded operations not possible using existing techniques.

In this section the degree to which the MARINE-VUE and STAR-VUE system meet these criteria will be evaluated.

4.3.1 MARINE-VUE

4.3.1.1 Efficiency

The hardware upgrades to MARINE-VUE greatly improved the efficiency of use of SINSS at the console. It is now no longer required for the operator to move to the vessels PPI display to acquire range and bearing information to identified ice features as was the case in the past. In addition, the ability to adjust the gain settings and improve near range resolution with the STC function allows the officers to produce a high quality image at the SINSS console.

4.3.1.2 Future Expandability

The ability to alter the marine radar video signal at the SINSS console highlighted the importance of using the vessel's radar in short pulse rather than long pulse mode. Previously, using bright radar displays at the SINSS console, the vessel's radar had to be operated in long pulse mode in order to produce a signal strong enough to be interpreted on the bright CRT display. However, now that the video signal can be manipulated at the SINSS console, the short pulse signal provided a much higher definition signal than the long pulse. Figure 4.12 is a photograph of the MARINE-VUE display while the radar was operated in long pulse mode and Figure 4.13 is a photograph taken when the radar was operated in short pulse mode. The sharper definition of ice features on the MARINE-VUE display in short pulse as opposed to long pulse is

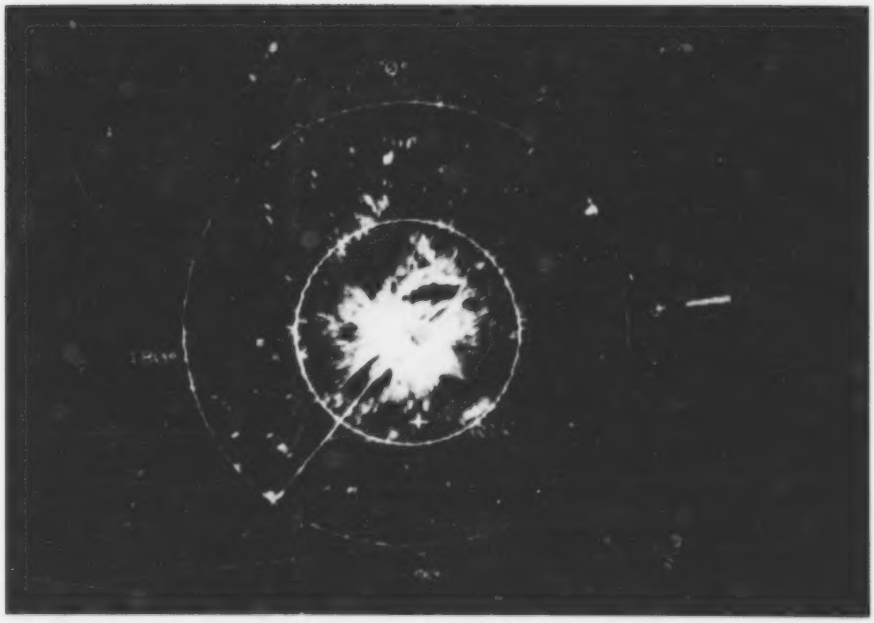

Figure 4.12: MARINE-VUE display with vessel's DECCA radar operated in long pulse mode.

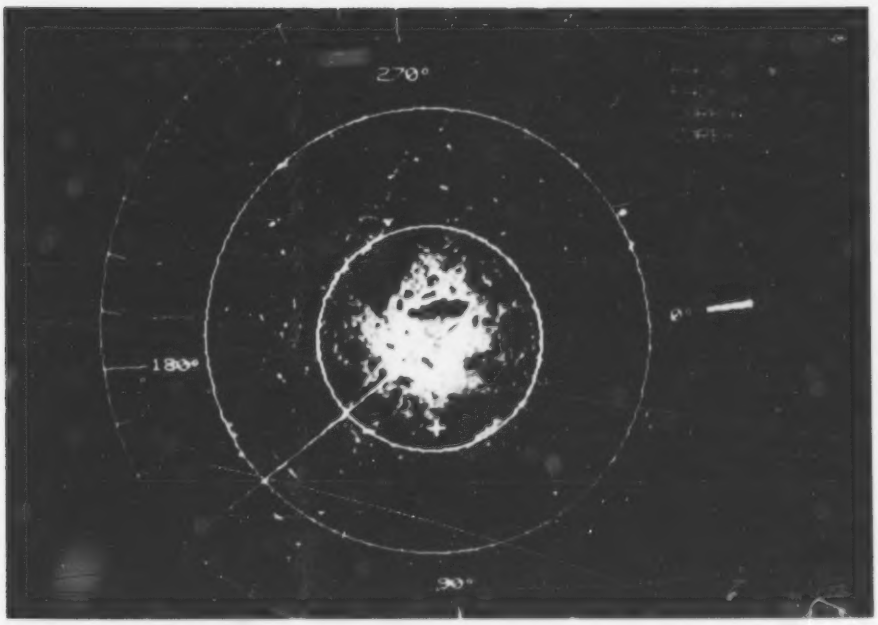

Figure 4.13: Same MARINE-VUE scene with DECCA radar operating in short pulse mode. Note much improved resolution on image.

readily apparent.

An important aspect of MARINE-VUE will be the systems potential to be adapted to new developments in the fields of marine radar and image enhancement technology. Canarctic has recently installed a new two-channel (horizontal transmit, horizontal and vertical receive) SPERRY radar system onboard the M.V. Arctic utilizing the new CHL dual polarized radar antenna. This radar system (the Arctic Marine Radar) will be dedicated to research into new radar techniques for Arctic navigation. Although the Intera/TDC MARINE-VUE upgrades includes a provision for two channel radar video mixing, the inoperative colour video board on the FOLSOM radar scan converter (discovered during the MARINE-VUE installation) will have to be corrected in order for a test of the dual channel capabilities of MARINE-VUE to be possible.

A more serious concern with the FOLSOM scan converter is the limitation the hardware configuration has on future marine radar development initiatives. The FOLSOM scan converter is capable of digitizing at a rate up to 10 MHz which is half the 20 MHz available from the radar system. For future image processing function that may be developed, the full 20 MHz digitizing capacity will be required to maximize the marine radar video. In addition, the "closed" architecture of the FOLSOM scan converter will make the system difficult to adapt to new image enhancement technologies than systems based on more "open" architecture such as the VME bus. This compatability may prove critical for add-on systems that need near real-time access to the digitial data stream.

There are newer radar scan converters available and built in Canada which may overcome the above mentioned limitations of the FOLSOM unit. Canadian Marconi manufactures a scan converter based on the VME bus given the product name Raster Scan Display. This unit was briefly reviewed by Canarctic (1988b). An additional scan

converter available is produced by Crossbow Electronics under contract from the Department of Fisheries and Oceans to serve as a scan converter for ice navigation. This unit digitizes at a speed twice as fast as the FOLSOM unit (20 MHz) and is based on VME architecture. This unit may be a more appropriate canadidate for the MARINE-VUE system than the FOLSOM unit.

Therefore, although the MARINE-VUE system has a built in capability to handle the dual channel radar system, the FOLSOM radar scan converter greatly limits the future expandability of the system and alternatives should be investigated.

4.3.2 STAR-VUE

4.3.2.1 Efficiency

The STAR-VUE system with the MARINE-VUE upgrades was not the preferred choice of the officers for floe by floe tactical navigation. Rather, the officers chose to use the hard copy film. This reluctance to use the STAR-VUE system may be the result of three factors:

1) The officers unfamiliarity with the system
2) The system provided for an unduly complicated approach to a relatively straight forward problem, (ie. lack efficiency)
3) STAR-VUE did not function reliably for a long enough period for the officers to gain confidence in using the system.

The officers of the M.V. Arctic have, on several occasions, been exposed to the STAR-VUE system during the development phase onboard the vessel and, consequently, have some familiarity with the system. However, there still remains the question of crew training and manning levels required to operate a shipboard ice

navigation system. The navigating officers had little difficulty grasping the concept of tactical navigation using the hard copy film since it presented data in a "chart" like format. The issue of crew training on systems such as STAR-VUE and the impact this may have on acceptance of the technology will be a separate program to this study.

The floe by floe tactical navigation process is a relatively straight forward problem of matching the ice features identified on the marine radar display to those identified on the SAR imagery to ensure that the vessel remains on the planned strategic course (usually also selected using the SAR imagery). The first use of the SAR imagery after collection is to analyze the data to select the strategic course. This is accomplished by placing the SAR hard copy film strips together into a crude high resolution mosaic from which the tactical course is selected and marked on the film. Since STAR-VUE only allows the operator to view small segments of each line in high resolution at one time, it cannot be effectively used for the process.

Once the tactical route is selected, the position of the vessel is monitored and marked on the SAR by correlating features identified on both the marine radar and SAR imagery. With the hard copy product, the marine radar is operated in the standard "north up" mode with the orientation of the SAR easily adjusted on the light table. The position of the vessel is determined from range and bearing information derived from the marine radar display and measured on the SAR in using dividers, scale and compass rose. To emulate this process using STAR-VUE, requires the marine radar image to be oriented to the SAR, a non standard mode. In addition, the process of selecting the required image segment and from the "View Image" menu then moving to the confirm ships position menu requires many discrete actions of the track ball. In addition, the response of STAR-VUE can be slow, more than four minutes to display

the 48 m resolution SAR image for example. Once in the confirm position menu, the determination of the ships position was effectively accomplished with the "Query MARINE-VUE" function but the other operation of marking ships position were found to be slow and awkward. In essence, the STAR-VUE system provided a much more inefficient method for floe by floe tactical navigation than the hardcopy film, thus contributing to officer reluctance to use the system.

The most serious limitation to STAR-VUE during the field trial voyage was the software/hardware failures which occurred during operation. After one to two hours of use of the "confirm position" menu during the outbound voyage, several serious failures began to occur on STAR-VUE. The first noted failure was with the Query MARINE-VUE function. The message "Task already active" would appear on the Wyse terminal each time the function was selected and the operation would not function. The only remedy was to power down STAR-VUE and re-boot the software; a software re-boot alone would not clear the problem. Following the frequent failures of the "Query MARINE-VUE function", the "Mark Ships Position" function began to fail with a "memory protect violation" error appearing on the Wyse. Within one further hour of STAR-VUE use all confirm position functions would no longer work and the error "MSP Bad read on N" appeared on the Wyse each time the confirm position menu was selected.

The Canarctic STAR-VUE has been removed from the M.V. Arctic and sent to Intera Calgary for inspection. It is unknown at this time whether the difficulties encountered with the system relate to software problems (such as recurrsivity) or relate to a failure of a hardware component within the Canarctic system. Nonetheless, there is a danger that continued failure of STAR-VUE may errode the confidence of the officers in the system.

4.3.2.2 Future Expandability

The greatest limitation to the use of hardcopy film products for tactical navigation is that there is no room for expanded operation potential with the data. When digital SAR data is used, there is a great potential for new systems such as automatic tracking to MARINE-VUE as well as image enhancement possibilities between the marine radar and SAR.

In addressing the capabilities of STAR-VUE to be expanded to undertake new digital processing techniques involving SAR, one must first address the limitation of the DEC 11/73 computer used in the system. It was observed, during the field trial, that STAR-VUE was slow to undertake some functions, particularly the display of SAR imagery. It would appear that the present functions on STAR-VUE are maximizing the processing capabilities of the DEC 11/73 computer and, consequently, would limit the future expandability of the system. In addition the DEC 11/73 represents an older DEC computer model line and does not represent the state of the art available in new micro-processors.

An important aspect to any future application of digital image enhancement of marine radar and SAR images will be the high level of image portability between systems required. As such, the STAR-VUE system suffers from the same limitation noted previously for the FOLSOM scan converter of MARINE-VUE, than that of a closed architecture system. Recent advancements in systems integration now makes the design and construction of hardware systems following standardized "open" architecture format a necessity if systems are to be electrically compatible with new advancements in data processing. For example, a system based on the VME bus format can now call upon a wide range of state-of-the-art processors not available elsewhere. The unique methods through which data is handled by STAR-VUE through the DEC RX-11 makes that system

incompatible with new and advanced image processing systems available now and in the future.

5.0 Conclusions and Recommendations

The November, 1988, late season commercial voyage of the M.V. Arctic to the minesite at Nanisivik, N.W.T., provided for an ideal and successful operational evaluation of the TDC/Intera MARINE-VUE upgrades. The conclusions and recommendations from this field evaluation are divided into three sections; those dealing with the improvements to the MARINE-VUE video display, those dealing with the MARINE-VUE/STAR-VUE integration for vessel position fixing, and finally, conclusions and recommendations on the future direction of research into ice navigation technology that have come to light as a result of this field evaluation.

5.1 MARINE-VUE Video Display Enhancement

The MARINE-VUE system installed for the November, 1988, field trial evaluation provided a significantly improved video display at the SINSS console than available in the past.

Video Gain

The video gain control on the MARINE-VUE display proved to be a useful addition to the system. The boosting of the signal allowed for more ice detail to be visible in the middle range of the display and highlighted the importance of using the marine radar in short pulse rather than long pulse mode. The addition of the gain function allowed the weaker signals which result from shorter pulses to be boosted. In the short pulse mode, a much higher definition image was produced on the MARINE-VUE display compared to the long pulse mode. Based on this finding, the following recommendation is made:

Recommendation #1

It is recommended that varying the pulse arch length of the Arctic marine radar be experimented with to identify the optimum pulse length for the definition of sea ice on the marine radar display. Due to the RPF limitations imposed by both the marine radar and video processing equipment, such pulse compression could be investigated by varying the speed of the marine radar antenna.

STC Threshold and Time Constant

The STC threshold and time constant function proved valuable in reducing the near range saturation within the first nautical mile of range brought on by boosting the video gain. There was little noticeable effect between the different STC curves on the MARINE-VUE display. Since the influence of the STC function was limited to the first nautical mile of range, the affect of using different curves was not noticeable. Despite the use of the STC curves, the far range of the MARINE-VUE display contained little ice detail with virtually no detail being discernable beyond 4 n.miles of range. Given the range limitation, the following recommendation is made:

Recommendation #2

It is recommended that additional STC curves be tested that may boost the signal returns in the far range. In addition, research into radar video image processing should be undertaken that aims to improve the information available from existing marine radar signals.

Fast Time Constant

The fast time constant proved ineffective as an anti-rain clutter filter and corrupted the MARINE-VUE display with a high level of noise clutter. An adjustment to the high pass cut-off frequency of the filter may be required.

Display mode

The functions which allow the image on the MARINE-VUE display to be oriented in a format other than "north-up" functioned properly during the voyage. However, it is clear, based on comments from the officers using the system, that the MARINE-VUE display needs to be maintained in the standard "north-up" mode. There was too much confusion during the voyage when the Master or Ice Pilot moved from the north up PPI at the conning position to the MARINE-VUE display in the non-standard orientation. The results of the November field trail demonstrated that the orientation of MARINE-VUE will have to match the north-up conventional conning radar display to avoid confusion.

Radar Range Setting

The most effective range to set the MARINE-VUE system was found to be 3 nautical miles for tactical navigation in ice. Beyond 4 nautical miles virtually no sea ice returns were visible on the MARINE-VUE display. Consequently, when the auto scale function on STAR-VUE was activated and the range on MARINE-VUE was set to 6.6 n.mile range at 24m SAR resolution and 13.3 n.mile range at 48 m SAR resolution, the range of MARINE-VUE was set further than any useful ice returns were being generated. Therefore, the auto-scale function was not operationally used during the voyage.

The 4 n.mile limit to the effective range of the MARINE-VUE system is likely due to the configuration of the vessels radar optimized for conventional navigation and not the imaging of ice. Therefore, the following recommendation is made:

Recommendation #3

It is recommended that a feasibility study be undertaken to investigate all aspects of the existing marine radar system to identify what parameters may be altered to improve sea ice definition with range on the MARINE-VUE display.

Cursor Control and Image Overlay

The image overlay functions on MARINE-VUE were found to be a very effective addition to the video display. Comparative measurements between the PPI and MARINE-VUE found no discrepancies in the accuracy of the range and bearing readings on MARINE-VUE. The range rings were found to be useful but the interior rings were found to be disconcerting on occasion. Therefore, the following recommendation is made:

Recommendation #4

It is recommended that an option be made available to dis-able the interior range rings (while retaining the outside ring) on the MARINE-VUE display.

5.2 MARINE-VUE /STAR-VUE Position Determination

Unlike the MARINE-VUE upgrades, which were well received by the M.V. Arctic navigating officers, the STAR-VUE position determination upgrades were little used during the voyage.

Query MARINE-VUE

The query MARINE-VUE function was used on occasion when an exact position of the vessel was difficult to determine accurately from the hard copy film. The performance of the function was straight forward and uncomplicated but required the operator to re-select the menu option for each position line drawn. Since at least two or more such lines are typically used to confirm one position, the following recommendation is made:

Recommendation #5

It is recommended that the Query MARINE-VUE function, once selected from the STAR-VUE menu, remain active until terminated by a separate button on the STAR-VUE track ball.

Mark Ships Position

The mark ships position function suffers from a minor software error which mis-calculates the location of the cursor when drawing the actual route segment. The result is a misalignment of the actual ship's route with the desired way points by several pixels in the Y and the X axis. This software problem requires correction.

Comment Option

The comment option was extremely time consuming to use since it required the operator to enter textural information at each location whether it was required or not. Since the marking of the UTC time is all that is required for most positions, the following recommendation is made:

Recommendation #6

It is recommended that the entering of textural comments be made a separate operation from the time stamp operation. The time stamp operation should be activated by a single action of the track ball thus improving the efficiency of the task.

The small size of the textural information produced by the comment option is difficult to read. Therefore, the following recommendation is made:

Recommendation #7

It is recommended that the text size produced by the comment option be increased to improve legibility.

Centre Ship in Image

This function was found to be a useful addition to STAR-VUE which minimized the need to exit the "confirm position menu" during tactical navigation to re-fresh the SAR imagery. However, the STAR-VUE system is extremely slow in displaying high resolution SAR data, taking more than four minutes to display 48m resolution data. Since the vessel is usually moving towards the top or bottom of the STAR-VUE display, the following recommendation is made to help minimize the number of times the SAR needs to be re-freshed during the centre ship function:

Recommendation #8

It is recommended that the centre ship in image function be modified to allow the option to centre the ship at the "top" or "bottom" of the SAR display.

5.3 Future Directions in SINSS Technology Development

The TDC/Intera MARINE-VUE upgrades has produced a complete functional system to perform as a first generation SINSS. It had been identified in the final report of the SINSS program (Canarctic, 1988) that the upgrades to MARINE-VUE being completed as part of the TDC/Intera upgrades would be required to achieve the specification of a first generation SINSS. In this section, the direction of future developments to improve and enhance the first generation system are presented.

MARINE-VUE

The improvements to MARINE-VUE now allow this system to perform adequately as confirmed as a stand alone ice navigation aid. The TDC/Intera MARINE-VUE upgrades also included hardware to allow for the integration of a dual-channel (Horizontal Transmit - Horizontal and Vertical receive) marine radar system into the video display. Now that a two channel marine radar capability is available with the recent installation of the Arctic Marine Radar onboard the M.V. Arctic (Canarctic 1989), the following recommendation is made:

Recommendation #9

It is recommended that the two channel video mixing equipment developed as part of the TDC/Intera upgrades be operationally tested with the Arctic Marine Radar.

The major limitation to the testing of the two-channel capability of the new MARINE-VUE system lies with the inoperative colour video board of the FOLSOM radar scan converter. Therefore:

Recommendation #10

It is recommended that the inoperative colour video board be corrected and brought up to operational standards so that expanded testing of the MARINE-VUE system using a two-channel marine radar may be undertaken.

A more serious concern with the FOLSOM scan converter is the units relatively slow scan conversion speed compared to the rate available from the marine radar and the "closed" architeture of the system. There are now new scan converters on the market in Canada which may replace the FOLSOM unit and the following recommendation is made:

Recommendation #11

It is recommended that a market survey be undertaken to identify a more suitable radar scan converter than the FOLSOM model 8342. Such units as the DFO sponsored scan converter produced by Crossbow Electronics should be field tested as a possible replacement MARINE-VUE scan converter.

STAR-VUE

The greatest concern facing the expanded use of STAR-VUE within the SINSS structure is the apparent reluctance of the navigating officers to use the existing system onboard the M.V. Arctic. It is likely that this reluctance is due to a combination of factors including a limited amount of training and/or exposure to the system, an overly complex system to perform a relatively straight forward function and a lack of functional reliability with the system. A number of conclusions and recommendations have come to light concerning these issues as a result of the November field trial voyage.

The training levels required for operators of ice navigation equipment is becoming an important criteria now that first generation systems are available. Given that the acceptance of new technology onboard a vessel will depend on the amount of training and skill development required of the operator, the following recommendation is made:

Recommendation #12

It is recommended that the TDC support manning and training programs that address advanced ice navigation technologies.

Although the reluctance to use STAR-VUE may be partly related to a lack of familiarity with the system, the relatively complex system operation is also an important factor. In order for STAR-VUE to be used for tactical navigation, the marine radar display is required to be oriented in a non-standard format and only a small segment of the SAR may be viewed at one time. The process of displaying SAR can be a slow at times while the use of the hardcopy film is a relatively straight forward process. Consequently, the fall field trial voyage demonstrated that, despite the upgrades to STAR-VUE which allowed the system to be used for tactical navigation, the hard copy remains an indispensable part of the process.

However, it was also realized that there may be new techniques available in image correlation between SAR and marine radar that will require digital SAR data. In order for expanded use of STAR-VUE to be possible, the constraint imposed by the closed architecture and relatively slow DEC 11/73 processor of the system will need to be evaluated. Therefore, the following recommendation is made:

Recommendation #13

It is recommended that a replacement for the DEC 11/73 processor of STAR-VUE be investigated and that consideration be given to a hardware/software design that will allow the maximum flexibility to utilize the state-of-the-art in data processing available now and in the future.

References

1) Canarctic Shipping Company Ltd (1988a) Phase V Final Report - Shipboard Ice Navigation Support System report to Executive Services Branch, Marine Group, Transport Canada.

2) Canarctic Shipping Company Ltd (1988b) Initial Investigation of Canadian Marconi LN66HP Marine Radar as a Suitable Host for the Cross-Polarized Ice Navigation Radar report to Transportation Development Centre.

3) Canarctic Shipping Company Ltd. (1987a) Phase IV Final Report Shipboard Ice Navigation Support System report to Executive Services Branch Marine Group, Transport Canada.

4) Canarctic Shipping Company Ltd., (1987b) SINSS Winter Commercial Probe report to Canadian Coast Guard Northern.

5) Intera (1988) MARINE-VUE Users Manual.

6) Intera (1987) STAR-VUE Users Manual.

Appendix A

Letter to Intera Technologies Ltd

August 25, 1988

Result of Completion of Canarctic
MARINE-VUE Installation Contract

CANARCTIC
Canarctic Shipping
Company Limited
350 Sparks Street
Suite 1005
Ottawa, Ontario
Canada K1R 7S8
613 234-8414
Telex 053-4731

August 25, 1988

Mr. Peter Button
Intera Technologies Ltd.
2500, 101 6th Ave. S.W.
Calgary Alberta T2P 3P4

File: 4869-B

Dear Peter,

Please find enclosed; a short report on my activities in Montreal, an appraisal of the system as presently functional, including comments and suggestions, and a copy of the airway bill for the shipment of the remaining and unneeded equipment and tools. Also an invoice for same.

I left Ottawa on Sunday Aug. 21th. in the afternoon, after having rented a car for the expected duration of the contract. I arrived in Montreal Dorval airport in good time to recuperate the equipment consigned in my name at the air cargo counter. All indications from Intera were that a full size car would be sufficient to handle the totality of the shipment. After struggling to get all the boxes in the car for at least 30 minutes, I was able to leave with all the cargo in the car, albeit in a relatively unsafe loaded condition, having no choice but to put one heavy box behind the drivers seat, in a relatively high position.

I checked in the Ramada In and had supper after which I headed toward the ship's arrival point where I met with Scott Thornton. The ship completed docking around 10:00h pm, at which point the equipment was taken to the bridge, assisted by Mr. Thornton and the crew. All the boxes were opened and the equipment verified for damage. All was found in good condition, and I started to plan the installation for the next morning, verifying the availability of tools, wiring, and the location of the equipment. I left the ship around 00:30h that night and returned the next day around 08:00h AM. The whole day was spent gathering tools and material, and doing the actual installation. By supper time, most of the installation was completed and some tests could be performed. By this time, Mr. Thornton had already completed his installations and was conducting some tests with the IEEE-488 interface between STARVUE and the scan converter. The interface would not perform correctly until the serial connection link between the MVCP and the scan converter was made available.

At this point, it was clear that the VP was not functioning having a permanent offset of +4V that could not be corrected. Substantial time was spent, verifying connections and the incoming signals to the VP. Also, an error in the connection diagram had been found and corrected, the serial connection at the back of the VP was through the DB-9 connector and not through the DB-25 connector as specified in the instructions.

All these proved correct, and I then decided to contact Blair Cain. His feeling was that the MVCP was not communicating with the VP and he suggested that we use the spare units to eliminate the problem.
The spare units were pulled out of box #3 and tested in turn with the same results. I left the ship that night around 00:30h, to return the next morning around 7:30h AM.

The VP and the MVCP were opened to verify that no damage had been sustained during travel or otherwise. The units were found to be in good condition. I surmised that if the units were not communicating, it might be due to excessive cable length between the units or bad line characteristics, so a short line was made and the VP was installed alongside of the MVCP and the signals brought to it. Even with this short cable length, there was no communication between the units. Also, it was clear that there was a problem with the MVCP, since every time the track ball was used, the system monitor light would flash and the system would reset. I got in touch with Blair Cain again and he suggested that I hook up the wise terminal to the MVCP to test the unit from another angle. Attempts to connect the unit failed and Blair was contacted again for further details. Attempts to communicate failed again and I decided to invert the serial communication link wires between the MVCP and the VP. Communication started immediately and the problem was cleared identified as a wiring diagram error.

Further discussing the matter with Blair, we identified a third wiring error between the MVCP and the scan converter. A wire that should not have been connected, had been specified for connection in the wiring diagram. This was corrected and the erratic reset problem associated with the track ball was cleared.

It was then mid afternoon, and the rest of it was spent completing the installation, hooking up the LR-40 to the ship's gyro, and calibrating the signals in and out of the VP.

During all the preliminary tests, the monitor was hooked up to the scan converter with a single video cable connected to the composite output. When the remaining cables were hooked up, the whole display was red. The cabling was verified to ensure no cable inversion had occurred and that the connections were electrically sound.

The video signals were then inspected on the oscilloscope and the red one contained synchro information contrary to the usual convention whereby, the synchro information is usually on the green channel. Also the other video waveforms were noted to be bizarre without being able to accurately define what was odd. Nevertheless, further tests were made by inverting signals and disconnecting the red one. When the red channel was disconnected, information could be visualized on the screen, but at a very low intensity and the monitor adjustments at maximum. Yet, the dynamic range on all signals were the same except that the red one had synchro information. The red signal connected to any monitor input(green and blue) was able to drive this color to suitable levels. The monitor was thus determined fully functional. The red signal also had negative voltage polarity with positive going video information never exceeding 0V DC. The other channels had positive polarity with also positive going video information.

Blair Cain was then contacted to inform him of the situation. After discussions at Intera with Peter Button, I was requested to go to the airport and get the spare scan converter that had been sent the day before. Having to go to the airport, I decided to send to Calgary the equipment that was ready to go, having limited room in the car. I returned to the ship around 08:00h PM and installed the spare unit. The video performance was the same, except that all channels were the same on that unit and the red channel did not contain any synchro information. The signals were similar in appearance and amplitude to the green and blue signals on the TDC scan converter. I then decided to open the two scan converters to compare differences and identify possible damage.

The red signal coming from the RGB board in the TDC scan converter, had been connected to the Y-position output in the back panel and the red output was connected seemingly to an internal composite video source. That has not been corrected and the red signal cable has been connected to the Y-position output instead as a temporary solution.

After closer examination, it was determined that the trouble with the video signal was during blanking periods. When a sync pulse is active, the video signal should go to black reference level. Instead, the signal goes to full intensity. The video processor circuit in the monitor probably uses the signal level during blanking periods to adjust it's black reference level. The black reference not being at the right level, the circuit cannot perform correctly. One way or another, the video signal has a bad format and needs to be corrected. The same problem is present on both video processors.

After discussions with Peter Button, it was decided that the TDC scan converter would remain on board and the DFO one would be sent to Calgary along with the rest of the equipment.

The rest of the evening was spent securing the connections, cabling, and equipment. The equipment to be shipped was packed, the bridge was cleaned, all the tools picked up and the area made as tidy as before the work started. I left the ship that night around 03:30h AM to return around 10:30h AM the next day. A complete run test was made, and the equipment explained to the radio officer. I then left The ship around 12:30h PM to go to the airport where the remaining equipment was shipped to Calgary. I then returned to Ottawa after lunch to arrive around 17:00h PM on the 24th.

IDENTIFIED PROBLEMS:

1- Wiring diagram error. MVCP connector J1 connects to VP J1 connector, a DB-9 connector and not a DB-25 connector as in the documentation. Also on the same connector, pin #2 goes to pin #2 and pin #3 goes to pin #3 contrary to the diagram.

2- Pin #3 of the scan converter serial connection RS-232C-T, should have been left disconnected, contrary to the wiring diagram.

3- The head-up display does not work properly. Going from north-up display to head-up, the system rotates the radar image clockwise by the same number of degrees as the ship's heading while it should be rotating it counterclockwise to bring the image back to where it belongs. Stated otherwise, the system adds the ship's heading instead of subtracting it.
Also, the heading marker remains at the ship's heading instead of going at the top where it belongs and the image rotating around it as the heading changes.

4- The rotate image display that is based on the head up display is also wrong since it is bad.

5- When performing a system reset (PPI origin simultaneously pressed with PPI reset), the range does not resume to the setting on the control panel, but goes to 100 NM range instead. In order to clear this, the range has to be changed one click and brought back to it's position. A total of two scans elapses before the image is recovered.

6- When rapidly changing range, say from 2 Nm to 12 Nm (not uncommon), the display will change 3 times before resuming to the wanted range. A total of three scans are required for the display to be recovered. The problem is worst if the range is changed from one end of the scale to the other. A time constant should be introduced to ensure that only the last demanded position is sent to the scan converter when changing range.

7- The is no power switch on the MVCP making system start up and shut down awkward. This should be a standard feature.

8- The STC controls perform satisfactorily but the threshold control operates in reverse from what is expected. One would expect the "effect" to increase as one turns the control clockwise and not the opposite. The attenuation is good, but could go down to .3, as at maximum the effect is at the limit of what is needed so that no room for adjustments is left. The range seems satisfactory, but only ice infested environment will be the real test.

9- The scan converter video output has the wrong format and is incompatible with standard monitors. The signal could be used in a dark environment but would still require the monitor to be adjusted to it's limit with marginal performance. The display is certainly not usable in daylight.

10- The red output from the RGB card in the scan converter has been connected to the Y-position output on the back panel instead of the Red video output.

All other functions that could be tested in the available time were satisfactory and no degradation of the radar image was noticeable when compared with the ships radar. This should not be taken as a reference however, since the standard ship's display is not the best suited for ice navigation. A final and more detailed evaluation of the system should be made when the remaining problems have been cured and the ship operates in ice.

As a whole, we are fairly impressed with the appearance of the devices and the present performance.

Many thanks for the obvious intensive preparation made for this installation.

Please find following, a copy of the two relevant AWB for the equipment shipment.

Yours truly,

Charles Gautier

Charles Gautier
Project Engineer
Operations Development

Encl.: AWB
Invoice

Appendix B

TIES Agreement for Shipboard Ice
Navigation Support System

Task Requisition No.2
MARINE-VUE Installation
October 30 - November 2, 1988

MARINE VUE INSTALLATION

The ship was boarded on Sunday Oct. 30 in the morning. The Folsom scan converter was installed in the rack and connected. Test instruments were prepared and connected to the trig. and video outputs. The system was started to begin testing.

The trigger signal was found to be clean and essentially free of any distortion or spurious oscillations. The pulse length was measured at approximately 1 uS and the PRF at 830 Hz. with the radar on std-by, and approximately 1.5 KHz on 3 Nm and higher. On the 1.5 Nm range or lower, the PRF increases to 3.3 KHz while the trigger pulse width remains at 1 uS or so. At a PRF of 3.3 KHz, the Folsom Scan Converter exhibited an extreme slow down in command execution. This condition persisted even when the radar video signal was disconnected. When the PRF was reduced to 1.5 KHz, all functions were observed to return to normal.

Prior to this task on the ship, Intera experimented with the Scan Converter, trying to reproduce the problem reported in Montreal during the last installation. They found that when the PRF was increased in the vicinity of 5.8 KHz, the Scan Converter exhibited the reported problems. The fact that problems were experienced at 3.3 KHz on the ship, seemed to indicate that frequency doubling occurred after the input to the Scan Converter (2 x 3.3 KHz > 5.8 KHz). Even though the trigger signal was proper in all respects, the input configuration of the Scan Converter seemed to offer the potential for problems. The input signal was routed through a voltage divider network, to scale the signal down to TTL levels from 13.5 V at the output of the RDS. This modification of the Scan Converter proved unsuccessful at solving the problem, but was retained because of better characteristics in relation to the available input signal.

It was then decided to hook up a signal generator to the Scan Converter trig. input, to reproduce the conditions under which Intera previously made the measurements. It was found that the Scan Converter performances would effectively extend in the range of 5.8 KHz without any particular problem. The signal from the generator reproduced the amplitude of the radar trig. signal, but had a much longer duration than the radar signal. While the radar pulse is 1 uS long, the generator pulse is 20 uS or longer. The conclusion drawn at this point was that the pulse length had a direct effect on the performance of the Scan Converter.

It was decided to build a pulse extender to stretch the radar sync pulses to 20 uS or longer. The circuit was built and installed in the Scan Converter on the video output board. The modification did not significantly improve the performance of the Scan Converter at higher PRF rates. At the same time, a marked degradation in the image quality was noted. The removal of the pulse extender circuit restored the image definition.

Since the pulse extender did not improve the Scan Converter performance, the cause of the problem is still unknown. The only solution left was to reduce the PRF while maintaining the image definition. It was reasoned that since the image had proper definition at a PRF rate of 1.5 KHz, the image would retain proper definition if on in two sync. pulses were dropped at 3.3 KHz. A circuit was built to eliminate each other sync pulse thus reducing the PRF to 1.5 KHz. This circuit was installed in the RDS on the video board. As expected, this modification eliminated the Scan Converter problems at the higher radar PRF rates.

One other possible cause for the above mentioned problem would be the rise time of the sync pulses. Since time was limited and the system was operational, it was decided that further investigations in this matter would be made when the unit could be returned to the lab.

The other problem to investigate, was the non-standard color video signal, causing a very dim picture that cannot be improved even when the monitor controls are adjusted to maximum. The composite signal out of the Scan Converter was connected in turn to each video input of the monitor. Each color channel was verified to function properly when driven by the correctly formatted composite output. This test proved that the monitor functioned properly.

Each RGB output was in turn examined with the oscilloscope to determine their characteristics. All three channels had a dynamic range similar to the one on the composite output. Therefore, it was assumed that the faint picture was not caused by the video level. If the level had been insufficient for the RGB signals, it would also have been insufficient for the composite signal.

The video level during horizontal and vertical sync. was found to be high instead of being at the black reference level. Prior study of the monitor circuitry revealed that this signal configuration will cause the monitor to take as a black reference, the white level. When this happens, any video level lower than the white reference will be taken as a blacker than black level by the monitor. This is the reason why the monitor controls have to be taken so high to get any picture at all.

The documentation of the Scan Converter was studied to find out if the video color board circuitry had been designed to produce this signal configuration. As expected, the system had been designed to output standard video signals as opposed to what was present at the output. With the oscilloscope, it was discovered that no sync. signal was present on the video D/A converter chip input. It is probable that the connections were omitted during the conversion of the unit.

An attempt was made to restore the sync. signal to the chip input by using the external sync. output to the monitor and connecting it to the chip input.

A connection error caused the sync. signal output amplifier and some related components to be burned. The damaged components were replaced with spare units on board, and the unit was repaired. A second attempt to reconnect the sync. signal to the video D/A converter chip was only partially successful, with some improvement of part of the picture. It was decided that the problem was more severe than expected and that insufficient equipment was available on board to further investigate this matter. The unit would have to be returned to the lab. for further testing at a latter time.

The green channel of the monitor was connected to the composite output of the Scan Converter in order to make the Marine-Vue system functional. The picture was judged to be fully acceptable and the installation was finalized.

Conclusions:

It is clear that all components of the Marine-Vue other than the Scan Converter were performing as expected with a high degree of performance.

The Scan Converter is the cause of the problems and has two major deficiencies; the incapacity to deal with the higher PRF even though rated to do so by the manufacturer and secondly, the inoperative color video board. This unit should be taken back to the shop and the above mentioned problems investigated further.